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Consanguineous Marriage and Reproduction in Beirut, Lebanon

Myriam Khlat[1]

Faculty of Health Sciences, American University of Beirut, Beirut

Summary

Effects of consanguineous marriages on couples' fertility and on offspring mortality were investigated in Beirut through a population-based health survey of 2,752 households. A multistage random sampling procedure was used, and information was obtained from all ever-married women in the household about their reproductive performance and genealogical relationship with spouse; demographic and socioeconomic information was also recorded. Twenty-five percent of all marriages were between relatives, and the spouses were first cousins in ~57% of all consanguineous marriages. Total pregnancies, live births, and living children were significantly higher among consanguineous couples than among nonconsanguineous ones, as was the proportion dead among children ever born. However, no difference remained in either fertility or mortality, when allowance was made for socioeconomic status, religious affiliation, and marriage duration. The issue of confounding is discussed, and the lack of significant pattern in the final analysis is interpreted as resulting from a long-term practice of consanguineous marriages.

Introduction

Studies of inbreeding effects on reproduction have led to divergent results. Some authors demonstrate a significant reduction of couple fertility when spouses are related (Reid 1976; Ansari and Sinha 1978); conversely, others show elevated levels of fertility among consanguineous couples (Schull et al. 1970*a;* Philippe 1974; Reddy and Rao 1978; Rao and Inbaraj 1979*a;* Bai et al. 1981); and, lastly, no significant pattern is observed in many instances (Tanner 1958; Devi et al. 1981; Reddy 1983; Hann 1985; Al-Awadi et al. 1986). Offspring of consanguineous couples are sometimes found to undergo a higher mortality, at various stages of prereproductive life (Cook and Hanslip 1966; Schull et al. 1970*b;* Fried and Davies 1974; Scott-Emuakpor 1974; Ansari and Sinha 1978; Reddy and Rao 1978; Naderi 1979; Bai et al. 1981; Farah and Preston 1982; Freire-Maia et al. 1983; Benallègue and Kedji 1984; Reddy 1985; Khoury et al. 1987*c,* 1987*d*), while a number of investigations fail to disclose any difference in this respect between inbred and noninbred children (Rao and Inbaraj 1977, 1979*b;* Devi et al. 1981; Reddy 1983; Al-Awadi et al. 1986).

Such discrepancies are difficult to interpret, the studies varying greatly in design (hospital-based/population-based, retrospective/prospective), age of individuals, sample size, selection of controls, and/or statistical analysis. Ultimately, there may be genuine differences between populations, either genetical or environmental, and, in particular, genetic effects may be obscured by large environmental effects (Rao and Inbaraj 1980; Khoury et al. 1987*d*).

Most of the above-mentioned studies have been conducted in India and Japan, few in the Middle East (Algeria [Benallègue and Kedji 1984], Israel [Fried and Davies 1974], Jordan [Cook and Hanslip 1966], Kuwait [Al-Awadi et al. 1986], and Soudan [Farah and Preston 1982]), and none in Lebanon. Still, the preference for the marriage of relatives is quite rooted

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Address for correspondence and reprints: Dr. Myriam Khlat, International Agency for Research on Cancer, World Health Organization, 150 Cours Albert Thomas, 69372 Lyon Cedex 08, France.

1. Present address: International Agency for Research on Cancer, World Health Organization, Lyon, France.

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in the Arab culture, and a recent population-based survey in Beirut discloses the proportion of consanguineous marriages to be as high as 25% (Khlat 1986); a previous, hospital-based survey has produced a quite similar estimate (Khlat and Khudr 1984, 1986). The situation that prevails in Lebanon is therefore particularly favorable for a study of inbreeding effects on reproduction. The assessment of such effects could in turn provide relevant information on the genetic structure of the population.

The aim of this study is to examine, in Beirut, the effects of consanguineous marriage on reproductive performance, in terms of fertility and offspring mortality. The data used for this purpose result from a population-based survey carried out during 1984.

Methods

Background and Selection of Control Variables

The two religious subgroups of the Lebanese population (Christians and Muslims) themselves comprise a total of seven main communities. Although no statistics are available, it seems reasonable to affirm that three communities (Sunnite, Shiite, and Maronite) predominate. The Druze, Greek Orthodox, Greek Catholic, and Armenian communities, of medium importance, are the remaining major communities. The other groups are smaller minorities. There is a notable religious endogamy, resulting in an isolation of Muslims and Christians, with some migration occurring inside each group (Khlat and Khudr 1986). As noted by Der Kaloustian et al. (1980), the degree of genetic impermeability varies widely according to the group.

Population-dynamics research in this context has long been impeded, mainly for political reasons. Empirical observations suggest that religious affiliation has a significant impact on fertility, and Chamie's (1977) analysis of the 1971 fertility survey of the Lebanese population demonstrated that both religion and socioeconomic status, as measured by wife's education, interact in determining total fertility.

No investigation of the determinants of childhood mortality in Lebanon has been undertaken so far, and Mosley and Chen's (1984) analytical framework for the study of child survival in developing countries is quite relevant for the purpose of our analysis. Mosley assumes that the social conditions of life are major determinants of child survival and that these determinants operate through a set of biological processes, or proximate determinants, to make their impact on the final outcomes of disease and death. Among the socioeconomic determinants, the most important at the household level is income or wealth. Household income indeed represents the current flow of economic resources to the family and, as such, is a good measure of the family's capacity to purchase health through food, medical services, and household amenities (Tekce and Shorter 1984). In a country such as Lebanon, where actual levels of income are very difficult to assess, occupation of the head of household is a relevant indicator of the financial strength of the household.

Knowing that in Beirut (1) low socioeconomic status and Muslim religion are associated with consanguineous marriage (Khlat, in press), (2) the rate of consanguineous marriage slightly declines with time (Khlat 1986) and (3) mortality as well (Zurayk et al. 1985), we would expect consanguineous marriages to have higher fertility and the children to have higher mortality, for demographic reasons (on the average, longer marriage duration) as well as for socioeconomic reasons (lower social classes). It was therefore deemed wise to control for religion, date of marriage, and the relevant socioeconomic indicator (either occupation of husband or education of wife) when investigating inbreeding effects.

Sample

A health survey of the city of Beirut was undertaken during the period July 1, 1983, to August 31, 1984, as part of an effort by the Faculty of Health Sciences of the American University of Beirut to establish a population laboratory for research purposes. The primary source of funding for this survey was the Ford Foundation, and a multistage sampling design was developed using an administrative division of the city into seven zones of approximately equal size in terms of number of buildings. The sampling procedure consisted of selecting, at random, sectors from the zones, then blocks of buildings from the selected sectors, and finally households from the selected blocks. Some 2,752 households were interviewed with respect to their socioeconomic conditions, morbidity, use of health services, environmental health, and perception of health. The survey covered 13,736 individuals, including 3,033 ever-married women. The following information items were recorded for each ever-married woman: (1) number of pregnancies, (2) number of spontaneous abortions, (3) number of induced abortions, (4) number of stillbirths, (5) number of child deaths, (6) education of both spouses, (7) occupation of both spouses, (8) religion, (9) date of marriage, and (10) genealogical relationship between spouses, categorized as (*a*) not related, (*b*) patrilateral parallel first cousins, (*c*) patrilateral cross first cousins, (*d*) matrilateral parallel first cousins, (*e*) matrilateral cross first cousins, or (*f*) more distant than first cousins.

When the woman had married more than once, items (6) to (10) related to the last marriage, and no information was available on the previous marriages. All women who had married more than once were excluded from the analysis. The complete sampling design and the preliminary results of this survey have been published as a book (Zurayk and Armenian 1985).

Statistical Methods

Analysis of covariance (Cooley and Lohnes 1971; Wesolowsky 1976) was used to assess the effects of parental consanguinity on, respectively, total pregnancies, live births, and living children, controlling for educational level of wife, religion, and marriage duration.

Logistic regression (Schlesselman 1982) was used to express child vital status as a function of parental consanguinity, professional status of father, and marriage duration. The goodness of fit of the model was tested by the Lemeshow and Hosmer (1982) test.

Results

The distribution of all marriages by genealogic relationship between spouses and by religion is shown in table 1. The overall frequency of consanguineous marriages reaches 25%, and marriages between relatives are more frequent among Muslims than among Christians. First-cousin marriages are a majority for Muslims (59% of all consanguineous marriages), while marriages between more distant relatives slightly predominate among Christians (52% of all consanguineous marriages). Lastly, patrilateral parallel-cousin marriage is the most prevalent type of first-cousin marriage in both religious groups (37% of all first-cousin marriages among Muslims, 38% among Christians).

For purposes of statistical analysis, parental consanguinity was classified into three types: (1) spouses who are first cousins, (2) spouses whose genealogical relationship is beyond that of first cousins, and (3) spouses who are not related.

Table 1

Distribution of Reported Genealogical Relationship between Spouses, by Religious Group

Religious Group and Relationship between Spouses	N	(%)
Christians:		
Consanguineous	165	(16.5)
First cousins	79	(7.9)
Patrilateral parallel	30	(3.0)
Patrilateral cross	8	(0.8)
Matrilateral parallel	19	(1.9)
Matrilateral cross	22	(2.2)
More distant than first cousins	86	(8.6)
Nonconsanguineous	836	(83.5)
Total	1,001	(100)
Muslims:		
Consanguineous	549	(29.6)
First cousins	322	(17.3)
Patrilateral parallel	119	(6.4)
Patrilateral cross	34	(1.8)
Matrilateral parallel	72	(3.9)
Matrilateral cross	97	(5.2)
More distant than first cousins	227	(12.3)
Nonconsanguineous	1,304	(70.4)
Total	1,853	(100)

Age-specific fertility patterns in the 1984 Beirut health survey have already been investigated (Zurayk et al. 1985), and one relevant distribution in this respect is reproduced in table 2. Ever-married women in the survey have produced 4.76 children by the end of their reproductive life. Besides, as pointed out by the authors, the fertility decline is notable; the number of children ever born per woman at ages 45–49 is 4.57, a figure almost double the 2.45 expected for the cohort of women going through their reproductive years at estimated 1984 levels of fertility.

Table 2

Children Ever Born, by Age of Mother

	Children Ever Born/1,000	
Age Range (Years)	Ever-married Women	All Women
15–19	702.13	36.87
20–24	1,550.42	444.04
25–29	2,430.11	1,424.37
30–34	3,389.22	2,808.93
35–39	3,960.00	3,586.96
40–44	4,491.28	4,055.12
45–49	4,756.68	4,566.95

Source.—Zurayk et al. (1985).

Table 3

Mean ± SD for Pregnancies, Live Births, and Living Children, by Relationship between Spouses, within Religious Groups

Religious Group and Relationship between Spouses	N	Mean ± SD: Pregnancies	Mean ± SD: Live Births	Mean ± SD: Living Children
Christians:				
Consanguineous	163	5.27 ± 3.10	3.93 ± 2.13	3.69 ± 1.99
First cousins	77	4.84 ± 2.97	3.58 ± 1.89	3.39 ± 1.82
More distant than first cousins	86	5.65 ± 3.19	4.23 ± 2.28	3.97 ± 2.11
Nonconsanguineous	820	4.30 ± 3.06	3.23 ± 1.96	3.06 ± 1.82
Muslims:				
Consanguineous	542	6.11 ± 3.85	4.88 ± 3.02	4.56 ± 2.73
First cousins	320	6.01 ± 3.90	4.87 ± 3.17	4.54 ± 2.85
More distant than first cousins	222	6.24 ± 3.77	4.90 ± 2.80	4.58 ± 2.54
Nonconsanguineous	1,276	5.46 ± 3.75	4.36 ± 3.21	4.08 ± 2.65

Considering the religious differentials in fertility (Chamie 1977), we have stratified all fertility analyses by religion. The mean numbers of pregnancies, live births, and living children per woman, by relationship between spouses, are given in table 3. The consanguineous group (all degrees of relatedness) shows significantly higher values than the nonconsanguineous one, for the three indicators of fertility and for both religions ($P < .001$ in all cases). Among Muslims, fertility of women in marriages between first cousins is quite comparable with fertility of women in marriages between more distant relatives, while among Christians fertility is consistently higher in the latter case. This pattern may result from socioeconomic differences between the two types of consanguineous marriages.

Analyses of covariance of, respectively, total pregnancies, live births, and living children by educational level of mother and duration and status of marriage are presented in table 4. No significant interaction is found between educational level of mother and duration of marriage, and the results are similar for both Christians and Muslims, indicating that, at the multivariate level, (1) status of marriage

Table 4

Analyses of Covariance (P value) of Total Pregnancies, Live Births, and Living Children, by Status of Marriage, Educational Level of the Mother, and Marriage Duration, within Religious Groups

Religious Group and Source of Variation	Pregnancies	Live Births	Living Children
Christians:			
Covariate:			
Marriage duration	.0000	.0000	.0000
Factors:			
Educational level of the mother	.0000	.0000	.0000
Status of marriage	.1838	.1537	.1120
Muslims:			
Covariate:			
Marriage duration	.0000	.0000	.0000
Factors:			
Educational level of the mother	.0000	.0000	.0000
Status of marriage	.7103	.9346	.6278

Note.—N = 2,623. Marriage duration: 0–4 years = 1; 5–9 years = 2; 10–14 years = 3; 15–19 years = 4; 20–24 years = 5; 25–29 years = 6; ≥30 years = 7. Educational level of the mother: illiterate, primary = low; secondary, technical = medium; university = high. Status of marriage: consanguineous; nonconsanguineous.

Table 5

Fetal Loss Rates, by Relationship between Spouses

Relationship between Spouses	No. of Pregnancy Terminations	Fetal Loss Rates (Per 1,000)
First cousins	2,123	144
More distant than first cousins	1,708	152
Not related	9,560	142
Total	13,391	143

no more has an impact on the three fertility measures, while (2) educational level of the mother remains highly significant.

Any pregnancy that did not terminate in a viable birth was classified as fetal loss, and fetal loss rates were computed per 1,000 pregnancy terminations, induced abortions being excluded from both counts (table 5). No significant difference is observed among the parental consanguinity groups.

We have calculated death rates among children, on the basis of the information collected from women concerning the number of children they had ever borne and the number of children who subsequently died. The proportion of child deaths to children ever born is a crude measure of child mortality in the recent past and has been tabulated by parental consanguinity (table 6). The observed rate for children whose parents are first cousins is significantly higher than the one observed for noninbred children ($P < .001$), while the one for children of distant relatives is not. In a second stage, the appropriate confounding factors were controlled for by using logistic regression analysis. For this purpose, the vital status of each

Table 6

Proportion Dead among Children Ever Born, by Relationship between Spouses

Relationship between Spouses	No. of Live Births	Proportion Dead among CEB (Per 1,000)
First cousins	1,818	70
More distant than first cousins	1,449	63
Not related	8,206	54
Total	11,473	58

NOTE.—CEB = children ever born.

Table 7

Linear Logistic Regression Model for Child Mortality

Variable	*P* Value	Odds Ratio (95% Confidence Interval)
Marriage duration	<.0001	1.24(1.18; 1.31)
Professional status of the father (rc: high):		
Medium	<.05	1.90(1.16; 3.11)
Low	<.001	2.73(1.66; 4.49)
Relationship between spouses (rc: nonconsanguineous):		
More distant than first cousins	>.10	1.22(0.89; 1.66)
First cousins	.05	1.33(1.00; 1.76)

NOTE.—rc = Reference category. Marriage duration: 5-year intervals, numbered 1–13. Professional status of the father: skilled, unskilled laborers = low; employees, clerks, school teachers = medium; professionals, large business, self-employed = high. No. of children: 7,780. No. of child deaths: 333. Logarithm of likelihood: −1321.3. Likelihood-ratio test: G2 = 107.6, 5 df; $P = .001$. Lemeshow-Hosmer test: H = 5.5, 3 df; c = 25.3, 18 df.

ever-born child was expressed as a function of marriage duration, professional status of father, and parental marriage status. The maximum-likelihood estimates of the final model of logistic regression for child mortality are presented in table 7. The regression coefficients show the following:

1. When high professional status is used as the reference category, children whose father has a medium professional status have a 1.90 higher risk of death ($P < .05$) whereas children whose father has a low professional status have a 2.73 higher risk of death ($P < .001$).

2. Risk of death significantly increases with exposure time, represented in the analysis by marriage duration ($P < .0001$). Given the time trend in mortality, longer marriage durations also correspond to higher period-specific mortality rates, and the observed significance may be interpreted in such terms as well.

3. With nonconsanguineous parents being used as a reference, children whose parents are related more distantly than first cousins have a 1.22 higher risk of mortality (nonsignificant) whereas children whose parents are first cousins have a 1.33 higher risk ($P = .05$).

Lastly, the selected combination of risk factors has a significant impact on risk of death among children (likelihood-ratio test), and the presented logistic model fits the data quite satisfactorily (Lemeshow-Hosmer test).

Discussion

Marriages between relatives are more frequent among Muslims than among Christians, and the overall cross-sectional proportion of consanguineous marriages is quite high (25%). A separate study has shown that the actual rate slightly declines with time and that this decline mainly reaches marriages between distant relatives whereas first-cousin marriages remain relatively stable (Khlat 1986). The perception of consanguineous marriages is still very positive in the population (Khlat et al. 1986), and the trend toward modernization in Beirut does not seem to weaken endogamy (Khlat and Halabi 1986).

We have investigated inbreeding effects on fertility (measured by number of pregnancies, live births, and living children) and on mortality (measured by fetal loss rates and proportion dead among children ever born). Our data consist of retrospective information and are therefore subject to recall bias. In particular, spontaneous abortions and stillbirths are the reproductive events that are the most likely to be underreported, resulting in an underestimation of both fetal loss rates and number of pregnancies. In the fertility analysis, we are using different indicators, and it seems reasonable to assume that live births and living children are less prone to recall bias than are fetal losses; in the mortality analysis, the same argument applies to the proportion dead among children ever born, when compared with fetal loss rates. Lastly, a differential recall bias among consanguinity groups could mainly result from socioeconomic differences; all our analyses control for this confounding factor.

The observation of an elevation of fertility with inbreeding is generally interpreted in the literature as a reproductive compensation mechanism, the assumption being that inbred children are at greater risk of death during infancy and childhood and that a child who dies young is replaced (Schull et al. 1970*a;* Reddy and Rao 1978; Rao and Inbaraj 1979*a;* Hann 1985). The role of reproductive compensation in the maintenance of genetic variability has been discussed (Templeton and Yokohama 1980). An alternative interpretation is reduction of the maternal/fetal incompatibility load by accrued genetic homogeneity (Feingold and Feingold 1971; Philippe 1974; Reddy 1985).

On the other hand, a number of studies demonstrate both depressed fertility of consanguineous couples and increased mortality of inbreed offspring, thus highlighting the detrimental effects of inbreeding, which are usually attributed to a greater homozygosity of deleterious lethal genes.

However, as has been stressed by Schull and Neel (1972), in much of the research on inbreeding effects, no proper allowance is made for possible socioeconomic biases, and a number of the observed differences among groups may entirely result from indirect associations. The epidemiologic approach to studying inbreeding effects is very promising in this context (Khoury et al. 1987*a,* 1987*b*).

In the Beirut sample, fertility is higher among consanguineous couples than among nonconsanguineous ones, within each religious group; the difference is no more significant, for the three indicators examined, when educational level of mother and duration of marriage are controlled for. It has to be noted that the socioreligious determinants of fertility operate through a number of proximate factors such as coital frequency, breast-feeding pattern, and use of contraception. Some information about these factors is available in the Beirut survey and has already been published. Sixty percent of married women were using contraception at the time of the survey, and the rate of utilization rises with age between the ages of 15 and 40 and declines thereafter (Zurayk et al. 1985). All women who reported having had a live delivery within the 2 years prior to the survey were asked about breast-feeding of last born. Bryce et al. (1985) mention that 76% of women report having breast-fed and that this proportion declines when the educational level of the mother rises. Differences among consanguinity groups with respect to these variables are accounted for in our analysis by controlling for education and religion.

The observed fetal loss rates are relatively low ($\sim$140/1,000), suggesting possible underreporting. No difference is observed among parental consanguinity groups for fetal loss rates; this may mean that the natural selection detected by inbreeding does not operate prenatally. Indeed, Khoury et al. (1987*a*), in a review of all previous studies of inbreeding effects on mortality, note that "the excess mortality for offspring of first cousin marriages can be seen for all periods of prereproductive life, but to a lesser extent for miscarriages and stillbirths."

Age at death of dead children was not available in the survey data, and it was therefore not possible to estimate either neonatal or infant mortality. The proportion dead among children ever born is a crude measure which does not refer to a particular period of childhood. Still, Brass and Macrae (1985) have shown that this indicator could be converted into precisely defined life-table indexes, by using appropriate multipliers and stratifying by duration of marriage or age of mother. For example, the proportion dead among children ever born to women married for less than 5 years could provide an estimate of the probability of dying before age 2, the proportion dead among children born to women married for 5–9 years could provide an estimate of the probability of dying before age 3, etc. When controlling for duration of marriage, the proportion dead among children ever born is therefore relevant for comparative purposes, although infant mortalities could be more sensitive to genetic causes. Nevertheless, several authors using overall mortality as the criterion report a significant increase of this indicator with inbreeding (Fried and Davies 1974; Ansari and Sinha 1978; Farah and Preston 1982).

In our logistic regression analysis of child mortality, the unit of analysis is the child—and the main problem is the lack of independence of children of the same mother. To overcome this limitation, we have reformulated the dependent variable at the mother's level of observation; for this purpose, an expected proportion dead among children ever born was calculated for each woman, based on marriage duration and the population life table (Coale-Demeny West model life table, mortality level 21). The ratio (observed proportion dead/expected proportion dead) was then considered as the dependent variable (this application is well documented by the UN Department of International Economic and Social Affairs [1985]) and expressed as a function of professional status of father, marriage duration, and status of marriage by using log-linear analysis. The results, not presented here (see Khlat 1986), show that, at the multivariate level, status of marriage is not associated with child mortality whereas professional status of the father remains a significant factor. This second approach leads to the same conclusions, but it has its own restrictions: the dependent variable is highly skewed (a great majority of zeros), and the assumptions of the method are usually not verified over a long time range, which leads to selecting only recent marriages.

In summary, our data show, at the univariate level, increased fertility of consanguineous couples and elevated mortality of inbred children. When the relevant socioreligious factors are controlled for, fertility no longer presents a significant pattern in relation to consanguineous marriage and the difference in mortality is marginally significant, while the socioeconomic and demographic factors explain a substantial proportion of the total variance. This analysis hence clearly illustrates the importance of properly controlling for eventual confounding factors. Second, our ultimate results support neither the reproductive compensation hypothesis nor the fetal/maternal compatibility hypothesis and, furthermore, do not convincingly demonstrate any detrimental effects of inbreeding on child survival.

Lastly, the argument that inbreeding effects are masked in the presence of high infant and childhood mortality (Khoury et al. 1987*a*) is not tenable in this context, since the estimated levels of child mortality in Beirut fall within low ranges (Zurayk et al. [1985] report an infant mortality rate of 22.8/1,000 for Beirut residents). In Lebanon, marriages between relatives have long been part of the social structure, and a lack of inbreeding effect on mortality may well mean that continued inbreeding practices entail, in the long-term, a progressive elimination of deleterious genes, as predicted by the population-genetics theory (Cavalli-Sforza and Bodmer 1971) and documented by several authors (Rao and Inbaraj 1979*b*, 1980; Khoury et al. 1987*a*).

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